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AUTHOR Wood, Eric F.; Floden, Robert E.
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ABSTRACT

A survey of prospective teachers' beliefs about teaching mathematics and writing to diverse learners was conducted for the purpose of improving teacher education programs. Respondents were 319 elementary education students, 71 prospective secondary math teachers, 52 prospective teachers of secondary English, 23 noneducation math majors, and 19 noneducation English majors. Although there is much diversity between and among the subjects, there were some areas of consensus. In answering questions about student diversity, the respondents did not endorse stereotypes about gender differences or differences in content appropriate for students from different family backgrounds. In responding to questions about what would be helpful in learning to teach, they gave the expected endorsement of experience, as well as high ratings for classes of questions about generic and subject-specific teaching methods. In answering questions about the mathematics or writing they would teach, the respondents expressed surprisingly little enthusiasm for seeing these subjects as systems of rules to be memorized. One difference of note was that the noneducation majors indicated less belief in the "power of pedagogy," that is, in the ability of prospective teachers to succeed in learning to teach academic content, especially more conceptually oriented content. Eleven tables are appended. (Author/LL)

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Where Teacher Education Students Agree:

Beliefs Widely Shared Before Teacher Education

by

Eric F. Wood

University of Western Ontario

1137 Western Road, London, Ontario, Canada.

N6G 1G7

(519) 661-2086 (ext 8682)

E-Mail: WOOD@EDU.UWO.CA

and

Robert E. Floden

National Center for Research on Teacher Education

Michigan State University

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Where Teacher Education Students Agree:

Beliefs Widely Shared Before Teacher Education[1]

Abstract

A study of prospective teachers' beliefs about teaching mathematics and writing to diverse learners is reported. Although there is much diversity between and among the subjects there were some areas of consensus. In answering questions about student diversity, they did not endorse stereotypes about gender differences or differences in content appropriate for students from different family backgrounds. In responding to questions about what they expected would help them learn to teach, they gave the expected endorsement of experience, but gave ratings almost as high to classes about generic and subject-specific teaching methods. In answering questions about the mathematics or writing they would teach, they expressed surprisingly little enthusiasm for seeing these subjects as systems of rules to be memorized. One difference of note was that the non-education students indicated less belief in the "power of pedagogy," that is, in the ability of pupils and teachers to successfully learn to teach academic content, especially more conceptually oriented content.

Introduction

Many of the current efforts to reform Canadian and American education are predicated on two beliefs: that improving the quality of the teaching force will improve the quality of education offered in schools; and, that better preparation of teachers can be provided through improved preservice and inservice teacher education programs. The first assumption is widely accepted; but the power of teacher education to shape teaching performance is still a topic for debate and investigation.

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Studying and improving teacher education both depend on having a clear sense of who is entering teacher education. Studies of what teachers learn in teacher education must draw on knowledge of what they knew before they entered. Attempts to improve instruction in teacher education, like attempts to improve any instruction, will be aided by knowledge about the students to be taught.

One persistent difficulty for educators and researchers comes from the diversity in any student population, including populations of propspective teachers. Diversity has great value for enriching discussions, helping students see other points of view, and generally adding interest to discussions. But diversity makes it difficult to gear instruction to the typical student, because no such student exists. Variability also poses challenges for researchers seeking to describe general patterns of growth and change.

In this paper, we will examine what commonalities can be found in a large, diverse group of teacher education students, spanning career stages, grade levels, and subject matters. What beliefs are shared by a majority of these students large enough that of the typical student makes some sense? We will search for these areas of consensus among the knowledge, skills, and dispositions that teachers need to teach mathematics and writing to diverse learners.

Common sense suggests that prospective teachers must believe that every individual can be taught and that some knowledge, skills, and dispositions about teaching can be learned in a teacher education program. If prospective teachers believe that pupil learning is largely determined by pupils' native ability and motivation, they have little reason to improve as teachers. Furthermore, if students perceive teacher education as merely a hurdle to be overcome for certification, they will have little reason to engage themselves in ways that would support their own learning.

Also important are the views teacher education students hold about the subjects they are teaching or will teach. For example, in mathematics, if elementary or secondary teacher education students are convinced that mathematics is strictly a skill subject that must be memorized, these views

are likely to cause problems for mathematics educators who believe in teaching mathematics from a conceptual viewpoint (Ball, 1988a; Brown & Cooney, 1982). Similar conflicts could occur between those who believe that it is more important to teach the mechanics of grammar than to encourage school children to express their thoughts.

If teacher education is aimed at shaping teachers' beliefs then it must take such ideas, attitudes and preconceived notions into account. As Brown and Cooney (1982) have pointed out, attention to teachers' beliefs about what and how they are teaching is important if teacher educators are to properly design teacher education programs. In addition, "It would be interesting and very helpful . . . . to know not only the nature of teachers' conceptual systems as they come to us but also how rigidly the systems are held and the extent to which they are modifiable" (p. 17).

A substantial body of evidence suggesting that teacher education students "accompany rhetoric about lively teaching with action in a routinized teaching mode that makes life in the classroom comfortable, if dull," (Tabachnick, Popkewitz and Zeichner, 1980, p. 27) complicates the task of accurately establishing the beliefs and attitudes of student teachers. Is this incongruity because students have the ideas and dispositions about teaching that they claim to hold changed as a result of their teaching experience, or is it because they merely spout views that they think their professors and supervisors want to hear? To answer this question, it is important to understand what students bring to their teacher education programs, both as a way of informing the design of those programs and as a way of establishing baseline data for studies of teacher learning.

The data in this report were taken from a survey of students in preservice, induction, and inservice teacher education programs as well as students in non-education programs. The majority (60%) of those in education programs were preservice students who have typically not yet taken any courses in education. In addition to the differences in type of program (pre-service, induction, inservice), the students differ by level (secondary, elementary), and subject specialization (mathematics, English). Respondents in the programs under study included 319 elementary students,

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71 prospective secondary math teachers, 52 prospective teachers of secondary English, 23 non-education math majors and 19 non-education English majors.

As expected, the respondents' beliefs on most questions vary widely. However, a high degree of consensus was found for a set of questions, questions that could mostly be grouped aroung a small set of themes. For those questions for which responses were collapsed to three categories, two criteria were used to judge consensus among groups: at least 75% of the sample chose the same response, and no group fell more than 10% away from the mean response in either direction. In the case of questions with four possible responses 65% overall agreement was required. Except for three items dealing with subject matter knowledge, all items on which there was a strong consensus were used in this report. This pool of items highlighted a number of themes which we then chose to explore further. After the themes were identified other questions in the survey that may not have satisfied either one or both consensus criteria were utilized to cross check and verify claims that seemed to be evident from the items on which there was consensus. In some cases these questions are included in tables for comparison purposes, alternatively the results are discussed in the body of the paper.

In order to establish areas where it was clear that people had opinions that were strongly held, the original 7 point scale which varied from 'strongly agree' to 'strongly disagree' with 5 variations in between, was collapsed to a three point scale where the top two and the bottom two categories were considered to mean agreement or disagreement respectively. The three middle categories representing uncertainty were collapsed into an ambivalent category.

Items selected were organized into themes that reflect the mission of the Center: What do teacher education students know about teaching mathematics and writing to diverse learners? Grouping questions into themes that reflect the issues of learning to teach; student diversity; and, ideas about writing and mathematics allowed us to frame three fundamental questions:

1. To what extent do students believe that teaching is a learnable skill and in what ways can this learning be accomplished?

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2. What are students' views about commonly held stereotypes in education, particularly those that deal with issues of equity both with respect to gender and socioeconomic concerns?
3. What are students' ideas about mathematics, writing, and the teaching of mathematics and writing?

Background[2]

Our analysis draws on data from the Teacher Education and Learning to Teach (TELT) study being conducted by the National Center for Research on Teacher Education (NCRTE) at Michigan State University (NCRTE, 1988). The TELT study attempts to inform current debate and curriculum reform in teacher education through a national study of what teachers are taught and what they learn in a diverse set of teacher education programs. The program-focused research component uses a combination of interviews and observations to describe program purpose, content, and character. The learner-focused longitudinal research component (where "learners" are learning about teaching) uses a combination of surveys, interviews, and observations to track changes in teacher education students' knowledge, skills, and dispositions related to teaching mathematics and writing to diverse learners. In this paper, we consider only the first wave of survey data from the learner-focused longitudinal study.

Although we will only consider baseline data in this paper, later reports will use additional waves of data to examine changes in knowledge, skills, and dispositions. Teacher education students typically enter the study just prior to the beginning of their professional education course or courses; the TELT study follows them through the middle of the first year after program completion. For example, undergraduates will be followed through the last two years of undergraduate study and into their first year of teaching. Since these students typically take the bulk of professional education courses in their junior and senior years, they will have taken few if any education courses when they complete the first survey at the beginning of their junior year. Students in fifth-year programs will

be followed through the last year or two of their program and into their first year of teaching. Those entering teaching through alternative routes will be followed during whatever instruction or supervision they receive prior to teaching, through supervised practice and into their first year of independent practice. First-year teachers in induction programs will be followed through that experience and through their first year of unsupervised teaching. Inservice teachers, to the extent possible, will be picked up some time prior to their participation in the inservice program, then followed through their inservice experience and for a year thereafter.

A broad sample of people took the survey, including teacher education students (elementary, secondary English, secondary math), liberal arts students (including math and English majors), and beginning and experienced teachers in the various programs. In most sites, the teacher education students (including beginning and experienced teachers) represent the entire population of students in the particular cohort of the program. Thus, inferential statistics (i.e., tests of significance of differences among groups or programs) are seldom appropriate--the differences reported are population differences.

The survey has over 300 fixed-response items, organized into categories of demographic information, knowledge (throughout this paper, we construe teachers' "knowledge" broadly to include beliefs, attitudes, and dispositions) related to teaching mathematics, knowledge related to teaching writing, and general knowledge about teaching. The survey takes approximately two hours to complete.

The survey was designed to tap teachers' knowledge of several domains important for teaching mathematics and writing to diverse learners, including knowledge of: subject matter and curriculum, context, learners, teaching and learning, and learning to teach. The survey designers recognized that different, even competing, visions of good mathematics teaching and good writing instruction exist. For example, some people believe that teaching writing well means focusing on structure and mechanics while others emphasize the processes of composition. Some people see the teaching and

learning of mathematics in terms of conceptual understanding and small group problem solving while others stress direct instruction in mathematical procedures and computational skills. Each approach rests on a view of teaching, learning and subject matter, and requires particular knowledge, skills and dispositions.

In thinking about subject matter, the survey taps what teachers and prospective teachers understand about math and writing and how they represent their understandings to themselves and others. Within any perspective on good teaching, teachers draw on their knowledge of these subjects. In the area of teaching and learning, the survey concentrated on teachers' goals of instruction in math and writing, or their ideas about how they should teach to meet those goals, and what it means to "learn" something. Knowledge about learning to teach includes teachers' ideas about what they need to learn and how they believe they can learn it.

Findings

Learning to Teach

Experienced teachers and teacher education graduates typically report that they learned to teach from their classroom experience, rather than from the courses or workshops they took. Hence, it is surprising that these respondents report they expect to learn almost as much from academic studies as from experience (see Tables 1 and 2). On the survey instrument one group of questions

Insert Tables 1 and 2

asked the respondents about learning to teach and the kinds of things that they might find useful as part of this process. (For a report that combines a more detailed look at these questions, together with relevant portions of TELT interview data for preservice respondents, see Amarel & Feiman-Nemser, 1988.) The scale employed was a four point rating of 'very helpful', 'of some help', 'of little help" and 'of no help'. In analyzing the results, the total proportion of the sample that answered the

question by choosing the 'very helpful' category was tabulated for each question on both the mathematics and writing surveys. To show areas of consensus, we display the four highest responses for each group.

The values given in Tables 1 and 2 list the percentage of respondents who classified each activity as "very helpful." In addition to the three categories where there was consensus that the activities would be "very helpful," we display--for comparison--the percentage of respondents who indicated that a course in the subject matter itself; or, watching and talking to other teachers would be helpful. Prospective teachers in both subject domains rate observation of other teachers much more highly than those who do not plan to teach. This response pattern suggests a belief by prospective teachers in the "power of pedagogy". These respondents strongly believe that teaching can be learned, and that it can be taught.

The value attributed to experience is consistent with other studies where students rate practice teaching as the most important part of their teacher education program. But students do not feel that experience is the only way to learn how to teach. Both knowledge of teaching methods and knowledge of content have some role to play in their development.

Furthermore, these respondents distinguish between subject matter knowledge and pedagogical knowledge. They responded differently to questions that asked about taking a course in teaching versus taking a course in the discipline. At the secondary level, groups who already perceive themselves to be knowledgeable about the subject are least likely to believe that taking more courses will help them improve their teaching skills; however, those groups that lack subject matter knowledge are the ones that believe most strongly in the helpfulness of a course in the subject matter itself.

Two contradictions to this response pattern are evident. No groups see as much value in taking a writing course as taking a course about teaching writing. Perhaps these people already believe that they know enough about writing to teach these skills. A similar argument would explain

why the elementary education students don't see the value of taking a math course: they believe they already have sufficient content knowledge to teach at the elementary level. Only 23% of the elementary respondents disagreed that basic computational skills and patience were the main requirements for teaching elementary school mathematics.

Most respondents seem to realize that both subject matter expertise and pedagogical knowledge are necessary for teachers. Will these ideas and attitudes change as these people come to learn more about what courses on teaching are like or how practicum arrangements and in-service programs are integrated into their development as teachers?

Stereotypes and Equity

A teacher must have teaching skills, content knowledge, and students to teach. The respondents' belief that teaching skills can be learned is important; however, the beliefs that they hold about the students that they will teach are equally significant. One ideal of Canadian and American education is to provide access for all students to equal educational resources. Evidence in the literature suggests that females are treated differently to males in mathematics classrooms (Becker, 1979) and they have lower scores on achievement tests. Writers in the sociology of education have demonstrated how students from working class homes are denied access to higher status knowledge (Anyon, 1981). If female students are invisibly filtered out of mathematics courses and students of working class parents are denied access to advanced level classes that will allow them to go to college or university, then one primary goal of the education system is subverted. Because teachers may contribute to this filtering, whether consciously or unconsciously, their attitudes toward teaching diverse learners are important. Furthermore, because these attitudes may be difficult to change, and may additionally shape the interpretations teachers make of their classroom experiences, it is important to know what knowledge and attitudes students bring with them to teacher education. (For further comments on the preservice teachers in this study's beliefs about student diversity, see Paine, 1988.)

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The respondents have strong opinions about equal access to knowledge for all students, regardless of socioeconomic background. The survey instrument presented the respondents with descriptions of two schools, one suburban and one urban and then asked the students to respond to questions about the content that ought to be taught in these schools and how they would expect students to perform. Respondents were asked to judge whether the situations presented in the questions should, or would, be the case in one or other of the two schools, both, or neither. The results of 4 questions from this grouping, two dealing with writing and two dealing with mathematics, are presented in Table 3.

Insert Table 3

These data reflect a clear belief in "basics": grammar and computational skills. It is also clear, although not quite so dramatically illustrated as their belief in the importance of basic skills for all students, that most students believe that "high status" knowledge should be accessible to students in both schools. Further confirmation comes from a crosstabulation of the two questions dealing with basic grammar and arithmetical computation: 93% of the respondents agreed that students in both schools should have access to basic knowledge in both subject areas. The crosstabulation of questions dealing with "high status" knowledge in both subject domains did not show the same degree of consensus; still, 77% of the students agreed that literature and higher level math topics should be part of the curriculum in both schools.

A slight discrepancy in the overall pattern of agreement comes from the two groups of math majors. Both those in education programs and those in mathematics per se do not believe that all students should learn about major works of literature, although they do think that students in both schools should learn high status mathematical knowledge. It would be easy to dismiss such differences as straightforward subject snobbery, except that the parallel pattern does not emerge when the English

majors respond to questions dealing with high status math topics. Perhaps these differences can be explained by an examination of how people view the utility of mathematics. When asked, 80% of the total sample said that mathematics is needed for many jobs and careers.

The strong belief in equal access to knowlege prompted us to examine another equity issue for comparison purposes, even though the items did not satisfy the consensus criteria. This second stereotype is that girls tend to be better at writing and languages, while boys tend to be better at mathematics. According to their survey responses, few entering teacher education students endorse this stereotype, though few strongly disagree with it either (See Table 4). A crosstabulation of 506

Insert Table 4

responses to two questions asking for a reaction to these stereotypes shows that only 4% agree with both statements, 21% disagree with both statements and 72% are uncertain about one or both statements. With baseline data such as these and students who have just started their study of teaching (at least for the preservice students) a lack of strong opinions is understandable. It is also notable, however, that although they may not as a group be sure about whether boys or girls are better at math, even the respondents who do have an opinion do not agree with the notion of male and female superiority in mathematics and writing respectively. Furthermore, differences between groups do not appear to be significant, for while the non-education mathematics majors agreed that males are better at math more than any other group, they also disagree more than most other groups.

The way that elementary teachers, who are still mainly female, teach mathematics may be influenced by their perceptions about the subject and their abilities in it. The claims that elementary education majors have poor attitudes about and fear and anxiety towards mathematics are not supported by these survey responses (See Table 5). In spite of this positive attitude, the elementary

Insert Table 5

education majors do not feel that you have to work hard at math to do well at it, whereas both groups of math majors do. Perhaps this pattern of responses means that the elementary people think that you need to have a mathematical mind to do well in math and that natural talent plays a large part in this success. (Questions asking about these two ideas, however, drew a largely ambivalent response.) The secondary math group and the math majors know from their course demands that work is a necessary factor in success no matter how mathematically minded you are.

Writing

Developing literacy is fundamental to the elementary curriculum. What literacy skills comprise is a subject of much debate. Critics point to test scores that show many students cannot write a grammatically correct sentence as evidence that more time should be spent on the basics. Many educators argue that students must first be encouraged to write about their own experiences and then taught that editing is a natural part of the writing process. A teacher education student who believed the former view would construct a different view of teaching writing than one who believed in the latter perspective. Consequently, the importance of understanding what teacher education students believe about writing and the teaching of writing is necessary for the development of effective teacher education programs. (For another perspective on preservice teachers' views about writing, see Gomez, 1988.)

All the respondents write frequently, although the non-education math majors write less than anyone else, including the secondary math majors who do not differ from any of the other groups on this point (see Table 6). This result points out one factor differentiating the two groups of math

Insert Table 6

students. The prospective secondary math teachers are more interested in communicating ideas than the math majors who are more interested in getting on with the task at hand than sharing it with others. This perception will be discussed later in another context.

The strong belief that writing is necessary to succeed in school is surprising; one might expect that there would be differences between the subject groups on this question, especially because the math groups believe that major literary works are not overly important for students in schools in low socioeconomic areas. Students at this stage in their academic training should have reasonably well developed writing skills and so they are likely to respond this way. However, a different explanation is possible.

Consider the first two questions in Table 7. These questions refer to the respondents' ability

Insert Table 7

to judge which writing tasks would be appropriate for a 7 or 8 year old. An overwhelming majority of respondents, across all groups judge the writing tasks outlined to be appropriate for a child in this age group. The final row gives the percentages of respondents who answered in each of the three categories, 'agree', 'ambivalent', 'disagree' to a similar task in the area of mathematics. These are tasks that children can do with appropriate instruction, though many of the tasks are not typically a part of the early elementary school curriculum. What is striking is the difference in the ability of the respondents to make such a judgement. There are considerable differences across all groups and a high degree of uncertainty about whether a child could be expected to perform such a task.

It appears that even for respondents who are math majors of one kind or another, the central role of writing in schooling is much more all pervasive than mathematics. All students who are now in university have experienced both mathematics and writing tasks while in elementary school and yet their perception of those skills and how difficult they are is different in the two subject domains.

Perhaps literacy and numeracy are not equally important goals in education; at least in the case of language and writing skills, most respondents have much better ability to judge where such skills fit into the elementary program. Furthermore, among the respondents to this survey, 59% claim to enjoy writing while only 47% say that they enjoy mathematics. Attitudes that underlie responses such as these are important for mathematics educators to understand and need to be addressed in teacher education programs.

Differences of opinion among groups about writing and learning to write reflect a process versus a product orientation (see Table 8). The first question makes a clear differentiation between

Insert Table 8

those people who are plan to teach and those who don't. All three groups of education majors line up against the non-education groups on this item. Whereas those not involved in teaching are technically minded about the production of a correct product, those in education are less interested in the finished product. Perhaps these people are also interested in the process that students go through to get the product, and, that in their view the process is also an important part of writing. This interpretation is supported by the results of a question asking respondents to judge two pieces of writing. One had grammatical errors but good ideas, the other was technically correct but shorter and with fewer thoughts about the topic they were asked to write about. The three groups of education majors judged the writing with the most ideas as being the best while the non-education groups judged the writing that was more technically correct to be best.

The prospective secondary math teachers have important ideas about the worth of children and the writing process that the non-education math group do not share. The secondary math majors think that all students have something to say and that writing helps you to think better. These two groups do align themselves once again; however, when it comes to students' interaction and discussion

of ideas. Neither group of math majors agrees as strongly that such communication is desireable. By contrast these two groups were both strongly in favor of whole group instruction as a way of teaching. In this regard at least there is a difference in attitude between the mathematics specialists (both teachers and not) and all other respondents. Perhaps these differences are partly due to the fact that many more elementary teachers are oriented towards language and arts than they are towards math. That might explain a closer resemblance between elementary and English respondents, than between elementary and mathematics respondents.

Mathematics

More than half of the respondents are elementary education majors; consequently, many of the students who claim not to enjoy mathematics would fall into this group. Unlike the English majors, who will never have to teach mathematics, the elementary majors will usually teach some mathematics. How will the attitudes about the subject influence their teaching? What attitudes do they hold with respect to mathematics? (For additional discussion and analyses of preservice teachers beliefs and attitudes about mathematics, see Ball, 1988a, b.)

The contention that elementary teachers think mathematics is dominated by memorization of rules is not supported by this survey (see Table 9). The respondents believe in the value of

Insert Table 9

understanding to the capable mathematics student. This belief in the importance of understanding is further corroborated by the results of a question asking if the reason for students inability to solve problems was not remembering the right rule or formula. The largest response category was ambivalent with 64% of the respondents indicating no strong opinion. Approximately equal numbers of respondents agreed and disagreed, with frequencies of 16% and 20% respectively.

The ambivalent result suggests that these people are coming into teacher education programs without strong pre-conceived ideas that mathematics is a subject simply involving memorization of rules and formulas. This finding is contrary to much work in the mathematics education literature, which claims that rote teaching and memorization are the commonest methods used in many mathematics classrooms. Furthermore, most respondents believe that to be good at mathematics (or writing) requires that individuals be logical in their approach. A crosstabulation of the two questions asking about the role of logic in the ability to write or do mathematics showed that 70% agreed that logical thought was necessary in both subjects with less than 1% disagreeing that it was necessary to do well in both. Statistics such as these suggest that mathematics and writing are perceived to be subjects that require thought rather than mechanical application of rules.

Respondents also believe that most things in mathematics can be explained (see Table 10). On

Insert Table 10

the three questions which asked respondents whether specific mathematical ideas could be explained or just needed to be memorized, less than 36% of the overall population said that memorization was necessary, although there were strong between group differences. As we noted earlier this finding runs counter to many other reports about the rote nature of mathematics teaching at all levels (Rombert & Carpenter, 1986). This situation may be an example of incongruity between what students say and what they actually do in their classrooms; however, the fact that they do appear to believe in the importance of explanations is crucial to the design of teacher education programs. The secondary math students seem to believe more strongly in the "power of pedagogy" than do the math majors. The non-education math majors are more inclined to think that students should just be told the rules so they can get on with it. The secondary math majors appear to have a strongly held belief in teaching as exemplified by the need to explain and justify.

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With respect to memorization versus explanation the elementary education majors appear to be more like the non-education math majors than the secondary math majors. However, similar levels of agreement do not necessarily imply a similar attitude on their part. The math majors have more mathematical knowledge at their disposal, hence ought to know more ways to explain things. The elementary students are being asked if things can be explained but, in many cases they may not actually know how to explain the ideas in question. They might believe the ideas to be explainable but in the absence of the knowledge required to provide that explanation they respond either negatively or ambivalently. In spite of this lack of knowledge only a third think that memorization is necessary.

For example, the last item having to do with raising a number to the zero power could probably not be explained by many of the elementary students who said that it had an explanation. The response of the secondary math majors on this question illustrates that their knowledge puts them in the position of knowing just how difficult a concept this item represents. This knowledge then causes them to claim that it does not have an explanation more often that the elementary group. By comparison, the math majors have the same knowledge as the secondary mathematics majors but their lack of belief in the necessity of explanation shows up in their even higher agreement with the need to memorize this rule.

Responses from the 9 elementary sites range widely on the first item dealing with memorization versus explanation. The inservice sites agreed only 7% of the time; the induction site agreed 7% of the time and the preservice sites agreed 39% of the time. This last value is not representative of the preservice sites as a whole, however, because their levels of agreement range from 50% to 0%. This pattern of agreement for the three types of sites as well as for the different preservice sites is maintained for the responses to the three specific questions in the table. (It should be noted that the four questions in Table 10 did not appear in the survey as a contiguous block, the first question was early in the questionnaire while the other three were almost at the end.)

Where teacher education students ...

The attitude that mathematics has to be memorized rather than explained is fundamental to the teaching of the subject but also to the value that one ascribes to that subject. If mathematics is simply a set of rules to be learned and mechanically applied then it is unlikely that it is of any value in teaching people how to think. In Table 5, a series of questions about respondents' attitudes towards mathematics and the learning of mathematics were tabulated. The second question about learning to think better provides a way of cross checking the responses of people on the question that asked if mathematics could be explained. A Pearson r of -0.3 was calculated for 543 responses on these two questions over the 9 sites in the elementary group, suggesting that strong agreement with memorizing math concepts is linked to a weak agreement about math helping you to think.

There are two possible interpretations of why students feel this way about mathematics. One is that it was taught to them in a rote fashion and consequently they do not think of it as a subject where original thought is important. Another possibility is that students simply don't believe mathematics to be a subject that helps you learn to think in the sense of being able to solve everyday kinds of problems. Consequently, there is no point putting any effort into using it for that purpose since the kind of thinking necessary in mathematics is of little value in other areas. Given the waste of time then it is easier and more efficient to just memorize the rules and learn to think somewhere else. In some sense, either belief would be a troublesome one for an elementary teacher to hold; however, at this stage of a student's education disentangling which is which would be very hard because at some point they become melded into one and the argument becomes one of the chicken and the egg.

Furthermore, there are large differences of opinion among sites. The percentage of respondents who agreed that math helps you learn to think better ranged from 100% to 54%. It is clear that such attitudes will affect the way that teacher education students construct meaning out of their preparation programs. Given the stated opinions it is interesting to speculate about where teachers develop the idea that mathematics (or writing) is essentially a mechanical activity and ought

to be taught that way. Perhaps respondents are answering the way that they think they should, or, perhaps the lofty ideals espoused here are difficult to put into classroom practice.

As previously discussed, respondents' beliefs about the ability of children to perform writing skills seemed to be more accurate than their beliefs about similar mathematics skills. The things that people do remember about mathematics, however, are what could be called 'rules of thumb'. A series of questions in both the writing sections and the mathematics portions of the survey listed rules of thumb to use while writing or doing mathematics. Respondents were then asked to decide if these rules were correct or not (see Table 11). The results illustrate that, not only do respondents remember

Insert Table 11

these rules of thumb correctly (these examples are all correct as stated in the survey) but they also think it is a good idea to teach them to students. The importance accorded rules of thumb could be interpreted as contradictory evidence to our contention that these teacher education students do not believe mathematics to be a rule oriented subject. This interpretation makes the assumption that a rule is provided without an explanation. Explaining why it is necessary to invert and multiply when dividing fractions is considerably different from stating this procedure as a rule to be memorized. Consequently, using or teaching rules of thumb is not necessarily inconsistent with the belief that mathematics should be taught in a way to promote understanding rather than rote recall.

By comparison, rules of thumb in writing are not well remembered. The last row in the table shows the corresponding results for one of the rules of thumb for the writing section of the survey. The comparison is similar to that in Table 7 where there was no sense of whether an 8 year old could correctly share the cookies.

These comparisons show that, for most respondents, some knowledge about mathematics and writing persists whether or not they continue to study that subject. They also point out, however, that

the kinds of knowledge people appear to have about the knowledge domains of writing and mathematics is quite different. People's beliefs about what children can do are accurate (and more optimistic) for writing tasks and most people enjoy writing more than mathematics. Conversely, rules of thumb for carrying out mathematical algorithms seem to be remembered better than rules of thumb about writing. It is possible that rules of thumb about writing have become second nature and no longer need to be explicitly remembered. Such an interpretation makes sense in light of the overall figures about how many students actually write. Probably, the number of students who would state that they do mathematics on a regular basis would be smaller (the survey did not ask).

Conclusion

Though the repondents in this study were intentionally chosen to represent variation--in subject matter, grade level, career stage, and teacher education program--they still approached consensus in some areas. In answering questions about student diversity, they did not endorse stereotypes about gender differences or differences in content appropriate for students from different family backgrounds. In responding to questions about what they expected would help them learn to teach, they gave the expected endorsement of experience, but gave ratings almost as high to classes about generic and subject-specific teaching methods. In answering questions about the mathematics or writing they would teach, they expressed surprisingly little enthusiasm for seeing these subjects as systems of rules to be memorized. One difference of note was that the non-education students indicated less belief in the "power of pedagogy," that is, in the ability of pupils and teachers to successfully learn to teach academic content, especially more conceptually oriented content.

What to make of these areas of consensus in unclear. These responses tend to be socially acceptable, but not always typical of practice. This may indicate that students enter teacher education with admirable goals, but are not always able to carry them out. It may also indicate that teachers try to please those who give them surveys.

Where teacher education students ...

Table 1 - Importance of Various Factors in Learning To Teach Math

Percentage of respondents who rated each alternative as 'very helpful' in Learning to teach MATH (Four point scale)	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
Improve general teaching skills, like how to motivate students	74	87	79	57	79
Take a course on teaching math	75	80	75	70	63
Get some (or more) experience teaching math	76	89	79	74	84
Observe other teachers and get their comments **	64	82	62	57	58
Take a math course **	47	31	75	41	68

** *These items did not satisfy the consensus criteria but were included for comparison purposes*

Where teacher education students ...

Table 2 - Importance of Various Factors in Learning To Teach Writing

Percentage of respondents who rated each alternative as 'very helpful' in learning to teach WRITING (Four point scale)	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
Improve general teaching skills, like how to motivate students	74	57	75	57	67
Take a course on teaching writing	74	66	67	61	67
Get some (or more) experience teaching writing	74	69	82	70	94
Observe or talk to other teachers of writing **	70	57	79	57	56
Take a writing course **	47	49	46	52	56

** *These items did not satisfy the consensus criteria but were included for comparison purposes*

Where teacher education students ...

Table 3 - Attitudes About Equal Access to Knowledge

Percentage of respondents who think that students in both schools should (Four point scale)	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
Learn grammar, spelling and the mechanics of writing	98	94	94	83	100
Learn math skills such as percents, multiplication and other basic computational skills	95	94	96	91	100
Be acquainted with the major forms and works of literature	85	63	88	74	100
Learn fundamental math concepts reflected in number theory and probability	87	80	89	78	90

Table 4 - Attitudes About Gender and Ability In Mathematics and Writing

		El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
In general, girls are better at writing than boys	(Ag)	10	20	11	22	5
	(Amb)	59	40	50	57	63
	(Dis)	31	40	39	22	323
In general, boys tend to be naturally better than girls at math	(Ag)	15	7	14	22	5
	(Amb)	51	48	39	30	58
	(Dis)	35	48	48	49	37

(Ag) = Agree
(Amb) = Ambivalent
(Dis) = Disagree

Table 5 - Attitudes Towards Mathematics And Learning Mathematics

Percentage of respondents who agree that	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
If they gave it a full effort they could learn advanced math **	62	86	52	96	74
Math helps you learn to think better **	63	85	54	79	68
To be good at math you Need to work hard at it **	66	82	73	83	74

** *These items did not satisfy the consensus criteria but were included for comparison purposes*

Where teacher education students ...

Table 6 - Attitudes About Writing

Percentage of respondents who indicated that	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
They do write frequently	93	97	100	87	100
* Letter writing is one kind of writing that they do	96	94	88	91	95
Writing is something students need to be able to do to succeed in school	89	86	90	87	100

Table 7 - Intuition About Children's Ability In Writing Versus Math

Percentage of respondents who think that 7 or 8 year olds can		El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
Choose appropriate words to fill in the blanks of a sentence		92	89	85	83	84
Write a sentence to accompany a picture the pupil has drawn		98	94	93	96	95
Decide how many cookies each member of a class of 24 would get if 12 dozen were shared out	(Ag)	51	49	40	52	42
	(Amb)	31	37	42	35	32
	(Dis)	18	14	17	13	26

(Ag) = Agree
(Amb) = Ambivalent
(Dis) = Disagree

Table 8 - Attitudes About Writing and Learning to Write

Percentage of respondents who agree that	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
Conventions of mechanics and grammar are critical for effective writing **	71	69	66	87	90
All students have something important to write about **	74	69	86	48	84
It is important that students learn to write so that they can share information with others **	81	63	86	65	79
Writing helps you learn to think better **	68	63	85	44	84
Students get better at writing by having opportunities to discuss their ideas with classmates and respond to one anothers writing **	85	54	86	48	79

** *These items did not satisfy the consensus criteria but were included for comparison purposes*

Where teacher education students ...

Table 9 - Attitudes Towards Success In Mathematics

Percentage of respondents who think that to be good at math	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
You must have basic understandings of concepts and strategies	83	92	90	91	95
You must have confidence that you can do it	87	83	83	78	79
You need to think in a logical step by step manner	76	85	87	87	90

Table 10 - Attitudes and Knowledge About Explanation Versus Memorization in Mathematics

Percentage of respondents who think you have to just memorize the fact that	El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
When multiplying two negative numbers the answer is positive **	35	30	27	52	32
The slope of a vertical line is undefined **	15	7	10	17	5
Any non-zero number raised to the zero power is 1 **	31	42	35	61	32
Percentage of respondents who agree that lots of things in math must just be accepted; there aren't explanations for them **	31	11	25	30	37

** *These items did not satisfy the consensus criteria but were included for comparison purposes*

Table 11- Knowledge of Mathematical Rules of Thumb Versus Rules of Thumb About Writing

Percentage of respondents who agree that (Three point scale)		El Ed Majors	Sec Math	Sec English	Non-Ed Math	Non-Ed English
To multiply by 10 it is necessary to move the decimal 1 place to the right		87	90	89	91	89
You should always do the same thing to both sides of an equation		83	94	84	82	90
To divide fractions you invert and multiply		89	83	89	83	94
Rules of thumb should be taught in math class		88	83	92	91	90
That a paragraph should always begin with a topic sentence	(Ag)	42	20	24	26	26
	(Amb)	41	57	41	57	53
	(Dis)	17	23	35	17	21

(Ag) = Agree
(Amb) = Ambivalent
(Dis) = Disagree

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2. Much of this section is drawn from NCRTE (1988).